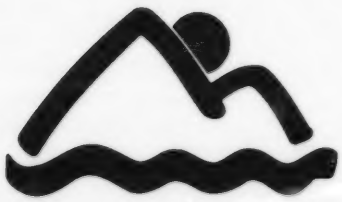
BC Environment

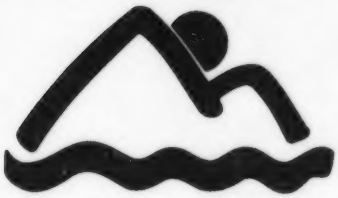
Municipal Solid Waste Composition Studies:

Summary Report



British Columbia
Handle with care

92-02537/



British Columbia
Handle with care

Municipal Solid Waste Composition Studies:

Summary Report

Municipal Solid and
Biomedical Waste Branch
Environmental Protection Division
Ministry of Environment, Lands and Parks
December 1991

Prepared by:
Gartner Lee Ltd.

Printed on recycled paper

Foreward

The Municipal Solid and Biomedical Waste Branch of the Ministry of Environment, Lands and Parks is charged with the implementation of the Municipal Solid Waste Management Strategy of the Provincial Government. The Branch coordinates the various efforts of governments, the public, industry and business as they work together toward the provincial goal of a 50 percent reduction by the year 2000 in the per capita generation of solid waste.

One of the most important elements of the Strategy is the solid waste management plan required of every regional district under Section 16.1 of the Waste Management Act. Many of the initiatives undertaken by the Branch are intended to provide assistance and guidance to regional districts in their planning efforts.

The "Guide to the Preparation of Solid Waste Management Plans by Regional Districts" stresses the importance of determining the composition of the regional solid waste stream as a necessary first step in devising strategies for reducing that waste stream. The "Requirements for Regional Solid Waste Management Plans" calls for updating this information every five years.

To assist regional districts in carrying out this task, the Ministry retained the firm of Gartner Lee Limited to devise a common procedure for determining waste composition and to apply that procedure to four community waste streams. This document provides a summary description of the results of the four waste composition studies and the methodology, while companion documents include the procedural manual that was developed, and a technical report on the methodology used.

R.J. Driedger, P.Eng.
Director, Municipal
Solid & Biomedical Waste

TABLE OF CONTENTS

	PAGE
MSW COMPOSITION – WHY IS IT IMPORTANT?	1
HOW TO DETERMINE MSW COMPOSITION	1
TESTING OF THE METHODOLOGY	3
VALIDATION OF THE METHODOLOGY	7
USEFUL INFORMATION FOR B.C. MUNICIPALITIES	9
MAPLE RIDGE SURVEY	9
KAMLOOPS SURVEY	12
CASTLEGAR AND LOWER SLOCAN VALLEY SURVEY	15
WASTE COMPOSITION	18
WASTE VARIABILITY	19
Community	20
Waste Sources	20
Residential and ICI Sources	23
Urban and Rural Sources	23
Seasonal Variation	24
MOISTURE CONTENTS OF WASTE CATEGORIES	24
VOLUME CALCULATION	30
REFERENCES	31

LIST OF FIGURES

		PAGE
FIGURE 1	AVERAGE WASTE COMPOSITION IN MAPLE RIDGE, KAMLOOPS, AND CASTLEGAR/SLOCAN VALLEY	18
FIGURE 2	MOISTURE CONTENT VALUES FOR MIXED REFUSE	28

LIST OF TABLES

TABLE 1	DETAILED LIST OF CATEGORIES FOR COMPOSITION ANALYSIS	4–5
TABLE 2	SUMMARY OF FALL AND SPRING SURVEYS IN MAPLE RIDGE	10
TABLE 3	SUMMARY OF WASTE COMPOSITIONS IN MAPLE RIDGE	11
TABLE 4	SUMMARY OF FALL AND SPRING SURVEYS IN KAMLOOPS	13
TABLE 5	SUMMARY OF WASTE COMPOSITIONS IN KAMLOOPS	14
TABLE 6	SUMMARY OF FALL AND SPRING SURVEYS IN CASTLEGAR AND SLOCAN VALLEY	16
TABLE 7	SUMMARY OF WASTE COMPOSITIONS IN CASTLEGAR AND THE SLOCAN VALLEY	17
TABLE 8	OVERALL WASTE COMPOSITION IN MAPLE RIDGE, KAMLOOPS, AND CASTLEGAR/SLOCAN VALLEY	21
TABLE 9	SUMMARY OF COMPOSITIONS OF WASTES ON COLLECTION VEHICLES	22
TABLE 10	COMPARISON OF FALL AND SPRING COMPOSITIONS (KAMLOOPS RESIDENTIAL WASTE)	25
TABLE 11	COMPARISON OF PERCENT COMPOSITIONS USING WET AND DRY WEIGHTS (KAMLOOPS RESIDENTIAL WASTE)	26
TABLE 12	MOISTURE CONTENTS OF WASTE CATEGORIES	29
TABLE 13	DENSITIES OF WASTE COMPONENTS AS RECEIVED AT THE DISPOSAL SITE	30

MSW COMPOSITION – WHY IS IT IMPORTANT?

Little is known about municipal solid waste (MSW) composition in B.C. The most frequently quoted data for B.C. were obtained during a study of Canadian communities over 100,000 from 1976 to 1977 (Bird and Hale, 1979). Due to changes in packaging, technology, lifestyle, attitude and disposable income since 1977, there is a need for up–to–date data for both urban and rural communities in B.C.

Knowledge of waste composition enables local B.C. governments to develop new management strategies to reduce, reuse, recycle and recover waste, as well as to manage residuals.

Composition studies carried out regularly also aid the monitoring of local government's progress in achieving the Provincial goal of 50% reduction in weight of waste discarded to landfills by the year 2000.

HOW TO DETERMINE MSW COMPOSITION

In October 1990, the British Columbia Ministry of Environment retained the services of Gartner Lee Limited to develop a manual on how to determine municipal; solid waste composition. This manual is called "Procedural Manual for municipal Solid Waste Composition Analysis" (GLL, 1991). It outlines in detail the steps to follow to organize and conduct a composition survey of the residential, and industrial/commercial/institutional (ICI) waste entering a municipal disposal facility. These procedures were designed to get the most information from the least amount of time, equipment and manpower. Following these procedures will ensure that data obtained is useful and consistent across B.C.

A common misconception about waste composition is that exact values need to be determined. The composition of waste varies with the day of the week, time of the year and area of collection. Knowing the exact contents of one waste collection vehicle has limited value since each truck contains different wastes. The methodology used in this study is

designed to estimate the composition of a waste stream by estimating the composition of selected loads. By studying the composition of loads throughout a week–long survey, repeated several times throughout the year, estimates of within–week and seasonal variability of the waste are possible.

Waste is analyzed as it arrives at the disposal site during single–week surveys. Ideally, wastes should come from the entire week being surveyed – including weekends.

For survey purposes, the waste stream is divided into smaller sub–waste streams according to the type of vehicle carrying the waste. Waste on collection vehicles is surveyed separately from waste on private vehicles hauling their own waste (also called self–haul vehicles). Depending on the waste collection practices of the survey area, the waste stream is further divided into waste from residential and ICI sources. The total stream is divided into the sub–waste streams described above since the compositions of wastes in these sub–waste streams are more homogeneous and can be quite different from each other. For example, wastes on self–haul (private) vehicles usually contain the bulky goods, white goods and excess wastes that are not picked up by collection vehicles. The composition of the total waste stream is estimated from the proportion of weight contributed by each sub–waste stream.

When possible, vehicles entering the disposal facility from the survey area were weighed to establish the amount of waste brought in. When there are no weigh scales at the disposal facility, collection vehicles are expected to pass by the nearest scales operated by the Ministry of Transportation and Highways. Vehicles are randomly chosen to contribute their waste to the survey.

Loads of wastes are taken for the survey either from waste collection vehicles or groups of private vehicles. Loads of waste selected for the survey are dumped away from other activity. To aid in the removal of large objects, loads are spread while being dumped. Large and readily identifiable objects are separated and weighed to get their percentage of each load.

Representative samples, about 120 – 140 kg in size, are taken from the remaining waste. Six or seven bags of waste about 20 kg each, are grabbed from random locations in the pile. These bags of waste are weighed and are sorted into the desired components on a sorting table. A detailed list of categories recommended for composition analysis is presented in Table 1.

Moisture contents of the sorted components are estimated by taking 100 – 500 gram samples to a lab for oven drying. The moisture contents of the various waste categories changes depending on the degree of cross–contamination and exposure to weather conditions during storage and collection. Moisture content is useful information for comparing composition results of different loads or different sources.

The suggested methodology is unique due to separation of waste into detailed categories, and the approach used to get reliable estimates. Few other surveys identify and deal with the various sub–waste streams which make up the total waste stream. The approach used is also unique in the way that large and bulky items are incorporated into the survey results. Finally, few other surveys consider the effects of moisture on weights and percentages.

The complete sampling methodology is presented in "Procedural Manual for Municipal Solid Waste Composition Analysis" (GLL 1991). This procedural manual describes in detail the design, organization and implementation of the waste survey. Recommendations for site requirements, equipment and supply lists, staff training, and the number of samples to take are included.

TESTING OF THE METHODOLOGY

Testing of the methodology produced estimates of the composition of MSW disposed of by four communities in B.C. The report "Determination of MSW Composition in Four Communities in B.C: Procedures Testing and Results" (GLL, 1991) contains statistical testing of the methodology as well as detailed results of the composition surveys.

TABLE 1
DETAILED LIST OF CATEGORIES FOR COMPOSITION ANALYSIS

• PAPER	– newspaper, including non–glossy magazines and flyers
	– corrugated cardboard and brown paper bags
	– fine / ledger paper, including bond and computer
	– glossy magazines and fliers, telephone books, books
	– packing paper–food boxes and trays, tubes, containers, waxed paper, etc.
	– aseptic beverage cartons
	– non–packaging paper, including towels, napkins, and mail not elsewhere classified (n.e.c.)
	– other paper, including multi–material combinations such as bubble packs, meat soaks, carbon or blue print paper, and window envelopes
	– contaminated paper, including disposable diapers and sanitary napkins
• GLASS	– beverage containers, refundable
	– beverage containers, non–refundable
	– food and other containers
	– other glass, including mirrors, plate, pyrex and multi–material combinations such as light bulbs
• METAL	– aluminum beverage containers, refundable
	– aluminum beverage containers, non–refundable
	– other aluminum including foil, tins and cookwear
	– steel beverage containers
	– other steel cans
	– other ferrous, including banding and machine parts
	– non–ferrous (copper, brass, lead, etc.)
	– other metal, including multi–material combinations
• PLASTIC	– Polyethylene terephthalate (PET) beverage containers, code 1*
	– other PET,
	– High Density Polyethylene (HDPE) – all colours, code 2*
	– Low Density Polyethylene (LDPE), code 4*
	– Polyvinyl Chloride (PVC), code 3*
	– Polystyrene (PS), code 6*
	– Polypropylene (PP), code 5*
	– other plastics, code 7*, Saran Wrap, acryl butyl styrene(ABS), and
	– multi–resin materials, such as laminates, and multi–material combinations, such as packaging n.e.c.;
• ORGANIC	– kitchen and restaurant waste, according to animal or vegetable origin
	– yard waste (grass, leaves, cuttings and stalks)
	– land clearing or landscaping debris, including brush, trees, large tree limbs and stumps
	– other wood, including pallets, scrap lumber and boxes
	– food and agricultural processing waste

* *from the plastic industry's voluntary coding system*

(TABLE 1 CONTINUED)

- **TEXTILES**
  - natural fibre
  - synthetic fibre
- **LEATHER** – including footwear with multi–material combinations
- **RUBBER**
  - used tires
  - other rubber products (including foam rubber)
- **WHITE GOODS** – including refrigerators, stoves, etc.
- **BULKY GOODS** – including office and household furniture
- **BROWN GOODS** – including electrical and electronic appliances and toys
- **CONSTRUCTION AND DEMOLITION DEBRIS**
  - gyproc
  - inerts including concrete, asphalt, bricks, rocks, and dirt
  - insulation, preserved lumber, and similar materials n.e.c.
- **RESIDUE** – including ash, ceramics and fines
- **HOUSEHOLD HAZARDOUS** – including the following categories of materials and the containers or appliances in which they were sold:
  - automotive supplies, including oil and other products
  - painting and decorating supplies
  - building and woodworking supplies
  - garden, pool and septic tank supplies
  - pet and hobby supplies
  - housecleaning and laundry supplies
  - medical supplies
  - lead acid batteries
  - dry cell batteries, by type, (alkaline, mercury, nickel–cadmium, lithium) and including batteries which cannot easily be removed from the appliance in which they were purchased
  - aerosol
  - cosmetic, personal products
- **OTHER MATERIALS, n.e.c.**

The communities selected for waste composition analysis were:

1) Kamloops:
   - an urban area with separate collection of residential and ICI wastes, with minimal source separation/recycling programs in place;

2) Maple Ridge:
   - an urban area with separate collection of residential and ICI waste, with a well established source separation/recycling program in place;

3) Castlegar:
   - a small community generating mostly residential wastes; and

4) Lower Slocan Valley:
   - three electoral areas of the Regional District of Central Kootenay, generating rural residential waste.

Composition estimates in the four study areas were obtained during two survey sessions. In the fall of 1990, wastes from Kamloops were surveyed at the Mission Flats landfill from Monday, October 29 to Saturday, November 3, wastes from Castlegar and Slocan Valley were surveyed at the Ootischenia landfill from Tuesday, November 6 to Saturday, November 10, and wastes from Maple Ridge were surveyed at the transfer station from Monday, November 19 to Saturday, November 24.

In the spring of 1991, the survey session began in Maple Ridge from Monday, February 25 to Friday, March 1, proceeded to the Ootischenia landfill from Tuesday, March 5 to Saturday, March 9 and ended in Kamloops from Monday, March 11 to Friday, March 15.

To perform the surveys for this report, Gartner Lee organized a survey team of an environmental engineer, a technician, and a sorting crew of four to five people. The survey team sampled and analyzed wastes on waste collection vehicles as well as some from private vehicles. Since both Castlegar and the Lower Slocan Valley were surveyed at one site, the

Regional District of Central Kootenay provided an additional survey team from Tuesday to Friday for both surveys. While this additional labour was a great help, consistency was difficult to maintain since different workers were available during the surveys.

Waste in Kamloops and Maple Ridge was divided into residential wastes on collection vehicles, residential wastes on private vehicles, ICI wastes on collection vehicles, ICI wastes on private vehicles, and other miscellaneous wastes. The sub–wastes streams for Castlegar and Slocan Valley were: combined residential and ICI wastes on collection vehicles, residential wastes on private vehicles dumping at the tipping face and wastes on private vehicles dumping at a separate location, referred to as the wood pile.

VALIDATION OF THE METHODOLOGY

The goal in composition analysis is to provide a reliable estimate of the percentage composition of each sorted category. Increasing the number of samples analyzed improves the reliability of the results. Composition analysis is labour intensive and getting samples can be costly and time consuming. However, results based on a small number of samples can misrepresent the waste stream being studied.

Determining the number of samples to take requires a trade off between the desired reliability of the results and the resources necessary to get and sort the samples.

In general, fewer samples are needed to get reliable estimates of some waste categories than for others. The waste categories that require the fewest samples are the major categories of: paper, glass, metals, plastics, organics, textiles and residue as well as some sub–categories: newspaper, cardboard, glossy magazines/telephone books, packaging and non–packaging paper, glass containers, steel cans, multi–material metals, rigid HDPE and LDPE film plastics, and organic kitchen wastes. The other waste categories need more samples to get reliable estimates. In general, large and bulky items or those that are not as frequently found in the waste stream require a very large number of samples for reliable composition estimates. These large and bulky items are most often: white goods, bulky goods,

construction/demolition wastes, wood, and landscaping wastes. Examples of items rarely found in the waste stream are: leather, rubber, steel beverage cans, and non-ferrous metals.

The methodology of sampling, sorting, and analysis, as developed during the survey and described in the Procedural Manual (GLL, 1991), yielded reliable estimates of waste composition within the various waste streams studied. Statistical analysis revealed high levels of precision and generally low standard deviations of the means of most categories of waste for most waste streams studied.

The precisions of the composition estimates presented in this report were generally better than anticipated in view of research on previous studies. One reason is the methodology used for incorporating large objects into the estimates. Previous studies considered only the samples that were sorted into the desired components. Some previous surveys reduced large objects mechanically and mixed them into the load before taking the sample for sorting. This survey separated and weighed the large objects to determine their percentages of the load. The composition of the load was then estimated by combining the percentages of the large objects with the composition of the sorted sample.

Another reason that precisions were better than expected is the size of the sample sorted. A 136 kg (300 lb) sample size was used in this study, rather than 91 kg (200 lb) used in comparable studies. Composition estimates improve by increasing the size of the sample sorted.

Survey results from private self-haul vehicles were less precise than those from collection vehicles. The mixing of waste that occurs on the collection vehicles is helpful since 136 kg samples become more representative of the waste stream. When surveying wastes from private vehicles in which no mixing occurs, a large number of vehicles need to be surveyed.

A minimum of six samples from collection vehicles and a minimum of 10% of wastes on private vehicles is recommended to obtain reliable estimates from future surveys.

USEFUL INFORMATION FOR B.C. MUNICIPALITIES

A second method of waste stream assessment involves using information from existing waste stream assessments, along with local knowledge of the waste stream. Information from communities with similar demographic characteristics and waste sources can be extrapolated to fit the local waste stream. Collection services and facility operators can be excellent sources of local information. This method is less expensive so it may be especially appealing to smaller communities or those with severe financial constraints.

There are a variety of factors that affect waste composition so this method should be used with caution. Waste surveys represent only a snapshot of a waste stream and therefore, data depend on the particular waste stream being surveyed, and on the time at which they are performed. Any extrapolation or reinterpretation of the data may produce misleading results.

MAPLE RIDGE SURVEY

It is estimated that the population of Maple Ridge is well over 40,000. The community is a popular home base for commuters who work in Vancouver.

Municipal solid waste is collected by private contractors hired by individual householders and businesses. Residents who choose not to have their waste collected, or who exceed the two–bag limit imposed by the contractors, may discard their own waste at the Maple Ridge transfer station.

Maple Ridge has a well–established recycling program, run by the Ridge Meadows Recycling Society. Free curbside pickup of newspaper, tin cans, and glass is provided. The recycling depot, located beside the transfer station, also accepts cardboard, fine paper, used oil, metals, and white goods, all at no charge.

For 1990, it is estimated from information provided by the GVRD that the total amount of waste discarded by Maple Ridge citizens (excluding that recycled) was 17,133 tonnes. This amounts to about 428 kilograms per person.

Wastes from residential collection vehicles were surveyed for composition both in the fall and spring surveys. Selected loads of ICI wastes were also surveyed during the fall and spring. Self–haul residential wastes were not surveyed in the fall, but samples were taken from residential self–haul vehicles during the spring survey. Wastes from other sources including ICI self–haul were excluded from the composition study due to budgetary constraints.

Table 2 summarizes the fall and spring surveys of Maple Ridge waste. For each sub–waste stream surveyed, the total amounts discarded and amounts surveyed during the survey periods are shown. Of the wastes surveyed, the amounts that were identified and separated as large or bulky objects are also shown. Finally, the amount of waste taken from the remaining waste for detailed composition analysis is shown.

TABLE 2: SUMMARY OF FALL AND SPRING SURVEYS IN MAPLE RIDGE

Sub–Waste Streams	Total Weight Discarded During the Surveys (tonnes)	# of Vehicles Surveyed	Total Weight Surveyed (tonnes)	Large Objects		Detailed Composition	
				Weight Separated (Kg)	% of Surveyed Weight	Weight Sorted (Kg)	% of Remaining Weight
Residential Wastes on Collection Vehicles	163.2	17	80.8	7,216	8.9	2,420	3.3
ICI Wastes on Collection Vehicles	331.7	7	47.7	6,882	14.4	1,125	2.8
Wastes on Private Vehicles	236.5	~90	10.2	4,659	45.7	489	8.8
Other Sources	30	–	–	–	–	–	–

Average wet weight percent compositions for Maple Ridge's sub–waste streams are shown in Table 3. The composition of the total waste stream is estimated using the average composition results of the fall and spring surveys and annual weight estimates of the various waste streams during 1990.

TABLE 3. SUMMARY OF WASTE COMPOSITIONS IN MAPLE RIDGE

Based on as-received (wet) weights COMPONENTS	RESIDENTIAL COLLECTION VEHICLES	ICI COLLECTION VEHICLES	PRIVATE VEHICLES	OVERALL
Paper (total)	**37.9%**	**42.8%**	**19.1%**	**33.0%**
newspaper	8.7%	9.1%	4.8%	7.4%
cardboard	4.5%	13.3%	3.5%	7.8%
fine	2.2%	3.0%	1.1%	2.1%
glossy / telephone	3.8%	2.5%	2.5%	2.8%
packaging	6.3%	5.1%	2.2%	4.3%
aseptic cartons	0.6%	0.2%	0.1%	0.3%
non-packaging	4.6%	4.6%	2.2%	3.7%
other / multi-material	1.4%	1.8%	0.7%	1.3%
contaminated	5.8%	3.4%	1.9%	3.3%
Glass (total)	**6.4%**	**4.0%**	**5.2%**	**5.0%**
beverage - refundable	0.9%	0.4%	0.7%	0.7%
beverage - nonrefundable	2.6%	1.7%	2.3%	2.1%
food	2.4%	1.3%	1.7%	1.7%
other	0.5%	0.6%	0.6%	0.6%
Metals (total)	**6.0%**	**6.1%**	**4.1%**	**5.3%**
alum. bev. - refundable	0.2%	0.2%	0.3%	0.2%
alum. bev. - nonrefundable	0.0%	0.0%	0.0%	0.0%
other aluminum	0.7%	0.7%	0.3%	0.6%
steel beverage	0.0%	0.0%	0.0%	0.0%
other steel cans	3.1%	1.9%	1.2%	1.9%
other ferrous	0.9%	2.0%	1.6%	1.6%
non-ferrous	0.0%	0.0%	0.1%	0.0%
other / multi-material	1.0%	1.2%	0.6%	0.9%
Plastic (total)	**8.8%**	**10.6%**	**5.1%**	**8.2%**
PET beverage (1)	0.1%	0.1%	0.0%	0.1%
other PET	0.1%	0.1%	0.0%	0.1%
HDPE (2) rigid	1.1%	1.5%	0.7%	1.1%
LDPE (4) rigid	0.3%	0.3%	0.2%	0.2%
HDPE (2) film	1.3%	1.1%	1.6%	1.3%
LDPE (4) film	3.5%	4.0%	0.9%	2.7%
PVC (3)	0.1%	0.2%	0.2%	0.2%
PS (6)	0.9%	1.0%	0.5%	0.8%
PP (5)	0.5%	1.0%	0.3%	0.6%
other plastics (7)	0.2%	0.2%	0.1%	0.2%
multi-resin / material	0.9%	1.2%	0.6%	0.9%
Leather	**0.5%**	**0.4%**	**0.2%**	**0.4%**
Rubber (total)	**0.3%**	**1.0%**	**1.8%**	**1.1%**
used tires	0.0%	0.2%	0.9%	0.5%
other	0.3%	0.7%	0.9%	0.7%
Organic (total)	**28.4%**	**21.5%**	**42.9%**	**30.9%**
kitchen - animal	4.0%	2.5%	3.0%	3.0%
kitchen - vegetable	17.4%	12.8%	10.0%	12.7%
yard waste	5.8%	2.9%	11.5%	6.7%
landscaping	0.2%	0.2%	13.1%	4.9%
wood	1.0%	3.1%	5.4%	3.5%
Textiles (total)	**2.8%**	**3.4%**	**2.2%**	**2.8%**
natural	0.9%	1.5%	0.3%	0.9%
synthetic	1.9%	1.9%	1.8%	1.9%
Brown goods	**0.6%**	**0.4%**	**0.3%**	**0.4%**
Bulky goods	**0.5%**	**1.6%**	**3.3%**	**2.0%**
Construction, Demolition	**1.3%**	**0.4%**	**10.9%**	**4.5%**
Residue	**4.1%**	**4.5%**	**2.3%**	**3.6%**
Household Hazardous	**2.3%**	**3.1%**	**2.3%**	**2.6%**
Other / White Goods	**0.0%**	**0.1%**	**0.1%**	**0.1%**

KAMLOOPS SURVEY

Kamloops, on the banks of the Thompson River, is a medium–sized city which in 1986 had a population of 61,773. It has grown dramatically to be the major industrial and service centre of the region.

The city of Kamloops owns and operates its own fleet of compaction vehicles for the collection of municipal solid waste. Residential collection vehicles are restricted to picking up 5 bags or containers per household per week. The self–haul waste stream consists mainly of brush and large bulky objects which the municipal vehicles will not pick up.

Most waste from Kamloops is discarded at the Mission Flats landfill. The Barnhartvale landfill and Heffley Creek landfill also receive residential waste. City collection vehicles and private vehicles containing ICI wastes are weighed at the entrance to the Mission Flats landfill. There is a charge of $15 per tonne of waste on ICI waste. Private citizens are not charged for discarding residential waste.

There is little recycling in Kamloops. However, there are drop–off depots for newspaper, fine paper, oil, and Christmas trees.

Based on information provided by the City of Kamloops, the estimated amount of waste discarded at all three landfills in 1990 is 42,650 tonnes. This amounts to about 690 kilograms per person.

Table 4 summarizes the fall and spring surveys of waste in Kamloops. For each sub–waste stream surveyed, the total amounts discarded and amounts surveyed during the survey periods are shown. Of the wastes surveyed, the amounts that were identified and separated as large or bulky objects are also shown. Finally, the amount of waste taken from the remaining waste for detailed composition analysis is shown.

TABLE 4: SUMMARY OF FALL AND SPRING SURVEYS IN KAMLOOPS

Sub–Waste Streams	Total Weight Discarded During the Surveys (tonnes)	# of Vehicles Surveyed	Total Weight Surveyed (tonnes)	Large Objects		Detailed Composition	
				Weight Separated (Kg)	% of Surveyed Weight	Weight Sorted (Kg)	% of Remaining Weight
Residential Wastes on Collection Vehicles	525.4	17	81.0	4,589	5.7	2,414	3.1
ICI Wastes on Collection Vehicles	377.4	8	52.0	7,964	14.3	1,077	2.4
Residential Wastes on Private Vehicles	644	214	46.0	44,403	96.6	140	8.9
ICI Wastes on Private Vehicles	169.3	–	–	–	–	–	–
Other Sources	16.3	–	–	–	–	–	–

Average wet weight compositions for the sub–waste streams in Kamloops are presented in Table 5. The composition of the total waste stream is estimated using the average composition results of the fall and spring surveys and annual weight estimates of the various wastes streams for 1990. This overall composition includes: residential and ICI wastes on collection vehicles, and some residential waste on private vehicles. These estimates do not include those wastes not surveyed: ICI self–haul and other sources.

TABLE 5. SUMMARY OF WASTE COMPOSITIONS IN KAMLOOPS

Based on as–received (wet) weights COMPONENTS	RESIDENTIAL COLLECTION VEHICLES	ICI COLLECTION VEHICLES	PRIVATE VEHICLES	OVERALL
Paper (total)	**36.4%**	**40.1%**	**1.55%**	**28.9%**
newspaper	10.2%	6.5%	0.27%	6.3%
cardboard	3.8%	8.8%	0.40%	4.8%
fine	2.4%	4.9%	0.27%	2.8%
glossy / telephone	4.1%	3.2%	0.24%	2.8%
packaging	6.3%	5.3%	0.15%	4.4%
aseptic cartons	0.3%	0.7%	0.00%	0.4%
non–packaging	3.6%	6.2%	0.05%	3.7%
other / multi–material	1.6%	2.1%	0.03%	1.4%
contaminated	4.2%	2.4%	0.13%	2.5%
Glass (total)	**5.6%**	**6.8%**	**0.60%**	**4.8%**
beverage – refundable	0.4%	0.9%	0.04%	0.5%
beverage – nonrefundable	2.7%	2.7%	0.17%	2.0%
food	2.1%	1.1%	0.19%	1.2%
other	0.5%	2.1%	0.21%	1.0%
Metals (total)	**5.5%**	**6.6%**	**2.12%**	**5.0%**
alum. bev. – refundable	0.1%	0.3%	0.01%	0.2%
alum. bev. – nonrefundable	0.0%	0.0%	0.00%	0.0%
other aluminum	0.6%	0.5%	0.13%	0.4%
steel beverage	0.1%	0.0%	0.00%	0.0%
other steel cans	3.0%	1.4%	0.13%	1.7%
other ferrous	0.9%	3.6%	1.55%	2.0%
non–ferrous	0.1%	0.1%	0.06%	0.1%
other / multi–material	0.7%	0.6%	0.24%	0.6%
Plastic (total)	**8.0%**	**7.5%**	**0.73%**	**6.0%**
PET beverage (1)	0.0%	0.1%	0.01%	0.1%
other PET	0.1%	0.1%	0.00%	0.1%
HDPE (2) rigid	1.3%	0.9%	0.16%	0.9%
LDPE (4) rigid	0.2%	0.2%	0.00%	0.1%
HDPE (2) film	2.9%	2.5%	0.05%	2.0%
LDPE (4) film	1.5%	1.4%	0.21%	1.1%
PVC (3)	0.1%	0.1%	0.10%	0.1%
PS (6)	0.8%	1.0%	0.04%	0.7%
PP (5)	0.4%	0.3%	0.01%	0.3%
other plastics (7)	0.2%	0.2%	0.00%	0.1%
multi–resin / material	0.6%	0.6%	0.14%	0.5%
Leather	**0.4%**	**0.2%**	**0.06%**	**0.2%**
Rubber (total)	**0.3%**	**3.1%**	**1.94%**	**1.9%**
used tires	0.0%	2.8%	1.75%	1.7%
other	0.3%	0.3%	0.19%	0.3%
Organic (total)	**32.6%**	**23.5%**	**65.07%**	**37.4%**
kitchen – animal	5.1%	2.1%	0.17%	2.8%
kitchen – vegetable	18.3%	15.7%	0.66%	12.9%
yard waste	8.2%	1.6%	1.76%	4.2%
landscaping	0.2%	0.7%	52.42%	13.6%
wood	0.8%	3.3%	10.06%	4.0%
Textiles (total)	**3.0%**	**2.4%**	**0.34%**	**2.1%**
natural	0.7%	0.5%	0.06%	0.4%
synthetic	2.3%	1.9%	0.29%	1.7%
Brown goods	**0.7%**	**1.5%**	**0.77%**	**1.0%**
Bulky goods	**0.3%**	**0.7%**	**1.89%**	**0.8%**
Construction, Demolition	**0.5%**	**2.5%**	**12.20%**	**4.2%**
Residue	**4.9%**	**3.4%**	**4.46%**	**4.2%**
Household Hazardous	**1.7%**	**1.6%**	**1.12%**	**1.5%**
Other / White Goods	**0.2%**	**0.0%**	**7.16%**	**1.9%**

CASTLEGAR AND LOWER SLOCAN VALLEY SURVEY

Castlegar, situated in the Central Kootenay Regional District of British Columbia, had a population of 6,385 in 1986. Historically the economy of the area has been based on the lumber industry, with a pulp mill and a large sawmill located in Castlegar itself and several smaller sawmills and shingle mills nearby. Castlegar is also the location of Selkirk College, a two-year post-secondary educational institution with an enrollment of close to 1,500.

Within Castlegar itself, solid wastes are collected and brought the Ootischenia landfill by a single private contractor hired by the city.

The Ootischenia landfill also receives the waste of about 6,500 people of the Lower Slocan Valley, specifically electoral areas I, J and a defined part of electoral area H. Three waste contractors service these communities. Since this service is not paid for with taxes, many individuals choose to save money by transporting their own wastes to the landfill.

White goods, tires, brush, and construction or demolition debris, including gyproc, are dumped at a special area called the wood pile. This is an area distinct from the tipping face. Wastes discarded at the wood pile are non-putrescible and are not covered as frequently as those at the tipping face to save cover material and landfill space.

Castlegar and the Slocan Valley have no formalized household recycling program. Used motor oil can either be dropped off at gas stations in town, or taken directly to a recycling depot. Lead acid batteries and propane tanks are separated from the waste at the landfill and are sold for recycling purposes. Cars are stored on-site and are periodically collected by a steel company which recycles the metals.

It is estimated that the amount of waste discarded annually at the Ootischenia Landfill from both Castlegar and Lower Slocan Valley is about 5,170 tonnes. This is about 400 kilograms per person. Since wastes are not monitored at the Ootischenia site, this annual estimate is based on information gathered during the two survey periods.

The composition of wastes from Castlegar and from the Lower Slocan Valley entering the disposal site on the collection vehicles was estimated in the fall and spring surveys. It was not possible to segregate residential from ICI wastes since these are combined on one vehicle servicing Castlegar. Collection vehicles servicing the rural areas of the Lower Slocan Valley contained mostly residential wastes. The composition of waste discarded at the woodpile by self–haul vehicles was estimated in both the fall and spring surveys. Self–haul vehicles discarding household wastes at the tipping face were only surveyed during the spring.

Table 6 summarizes the fall and spring surveys of waste from Castlegar and Slocan Valley. For each sub–waste stream surveyed, the total amounts discarded and amounts surveyed during the survey periods are shown. Of the wastes surveyed, the amounts that were identified and separated as large or bulky objects are also shown. Finally, the amount of waste taken from the remaining waste for detailed composition analysis is shown.

TABLE 6: SUMMARY OF FALL AND SPRING SURVEYS IN CASTLEGAR AND SLOCAN VALLEY

Sub–Waste Streams	Total Weight Discarded During the Surveys (tonnes)	# of Vehicles Surveyed	Total Weight Surveyed (tonnes)	Large Objects		Detailed Composition	
				Weight Separated (Kg)	% of Surveyed Weight	Weight Sorted (Kg)	% of Remaining Weight
Castlegar Collection Vehicle	108	12	71.5	7,056	10	1,791	28
Slocan Valley Collection Vehicles	25	10	19.6	1,522	8	1,362	7.5
Private Vehicles @ Tipping Face	32	115	7.4	2,885	39	536	11.9
@ Wood Pile	26	129	23.2	–	100	–	–
Other Sources	8	–	–	–	–	–	–

Average wet weight compositions for Castlegar and Slocan Valley are presented in Table 7. The composition of the total waste stream was estimated using the average composition results of the fall and spring surveys and annual weight estimates of the various wastes streams for 1990.

TABLE 7. SUMMARY OF WASTE COMPOSITIONS IN CASTLEGAR AND THE SLOCAN VALLEY

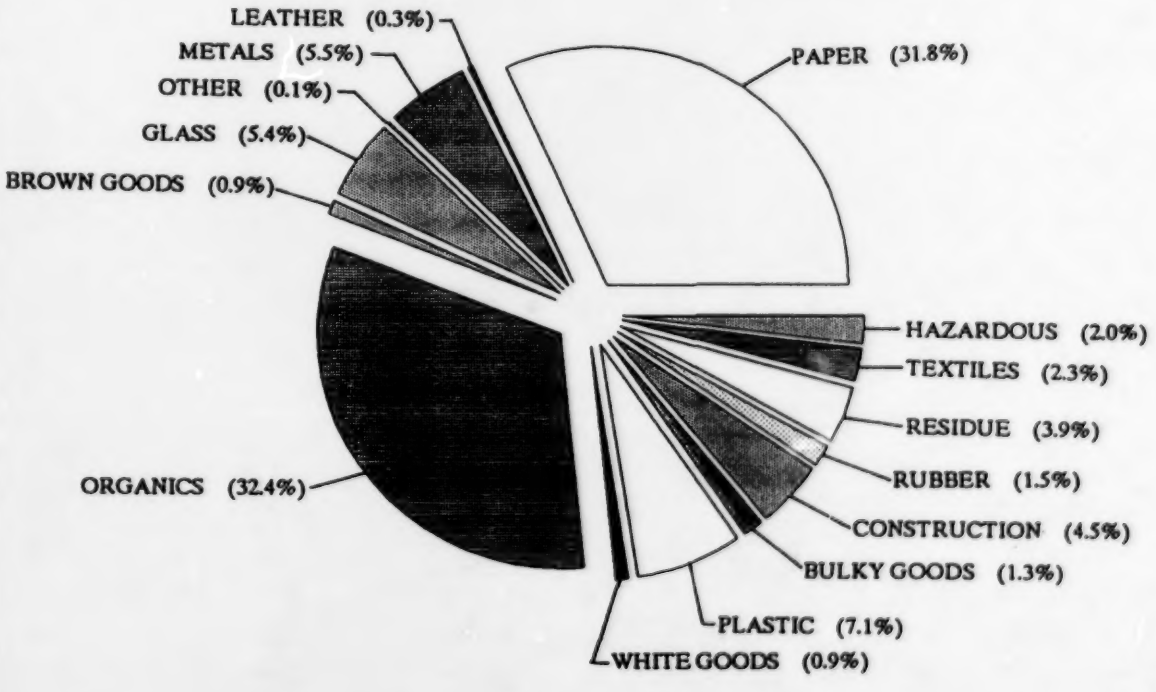
Based on as–received (wet) weights COMPONENTS	URBAN COLLECTION VEHICLES	RURAL COLLECTION VEHICLES	PRIVATE VEHICLES	OVERALL
Paper (total)	**42.6%**	**36.9%**	**14.9%**	**33.4%**
newspaper	7.7%	5.1%	2.1%	5.6%
cardboard	10.6%	7.6%	4.5%	8.4%
fine	3.5%	3.2%	0.9%	2.7%
glossy / telephone	4.4%	4.6%	1.7%	3.6%
packaging	5.5%	5.4%	1.8%	4.4%
aseptic cartons	0.5%	0.4%	0.2%	0.4%
non–packaging	5.3%	4.8%	1.1%	4.0%
other / multi–material	1.6%	1.2%	0.6%	1.2%
contaminated	3.4%	4.6%	2.0%	3.1%
Glass (total)	**5.6%**	**8.0%**	**7.3%**	**6.4%**
beverage – refundable	0.7%	0.9%	0.3%	0.6%
beverage – nonrefundable	2.2%	4.2%	2.3%	2.4%
food	1.7%	2.3%	2.0%	1.9%
other	0.9%	0.6%	0.7%	0.8%
Metals (total)	**5.9%**	**6.5%**	**6.9%**	**6.2%**
alum. bev. – refundable	0.2%	0.1%	0.0%	0.1%
alum. bev. – nonrefundable	0.0%	0.0%	0.0%	0.0%
other aluminum	0.4%	0.4%	0.5%	0.5%
steel beverage	0.0%	0.0%	0.0%	0.0%
other steel cans	3.1%	3.5%	1.4%	2.6%
other ferrous	1.4%	1.2%	4.4%	2.3%
non–ferrous	0.0%	0.2%	0.1%	0.0%
other / multi–material	0.7%	1.0%	0.5%	0.7%
Plastic (total)	**8.8%**	**8.5%**	**3.7%**	**7.3%**
PET beverage (1)	0.2%	0.1%	0.0%	0.1%
other PET	0.0%	0.1%	0.0%	0.0%
HDPE (2) rigid	1.2%	1.5%	0.7%	1.0%
LDPE (4) rigid	0.1%	0.2%	0.1%	0.1%
HDPE (2) film	3.2%	2.9%	0.3%	2.3%
LDPE (4) film	1.5%	1.6%	1.3%	1.4%
PVC (3)	0.1%	0.1%	0.1%	0.1%
PS (6)	1.0%	0.7%	0.3%	0.7%
PP (5)	0.3%	0.5%	0.2%	0.3%
other plastics (7)	0.3%	0.3%	0.1%	0.3%
multi–resin / material	0.7%	0.7%	0.5%	0.7%
Leather	**0.1%**	**0.6%**	**0.7%**	**0.4%**
Rubber (total)	**0.3%**	**0.3%**	**3.9%**	**1.3%**
used tires	0.0%	0.0%	3.5%	1.1%
other	0.3%	0.3%	0.4%	0.3%
Organic (total)	**26.0%**	**27.8%**	**34.4%**	**28.8%**
kitchen – animal	3.4%	3.3%	2.0%	3.0%
kitchen – vegetable	18.2%	22.4%	8.8%	15.9%
yard waste	2.2%	0.8%	4.3%	2.6%
landscaping	0.0%	0.1%	9.9%	3.0%
wood	2.1%	1.2%	9.4%	4.1%
Textiles (total)	**1.8%**	**3.1%**	**1.6%**	**1.9%**
natural	0.6%	0.7%	0.2%	0.5%
synthetic	1.3%	2.3%	1.3%	1.4%
Brown goods	**0.8%**	**0.7%**	**2.7%**	**1.4%**
Bulky goods	**0.3%**	**0.3%**	**3.0%**	**1.1%**
Construction, Demolition	**1.7%**	**1.1%**	**12.8%**	**4.9%**
Residue	**4.1%**	**4.4%**	**3.4%**	**3.9%**
Household Hazardous	**1.8%**	**1.5%**	**1.6%**	**1.7%**
Other / White Goods	**0.0%**	**0.4%**	**3.1%**	**1.1%**

WASTE COMPOSITION

Figure 1 presents the average of the overall waste compositions for Maple Ridge, Kamloops and Castlegar/Slocan Valley based on wet weight percentages. The entire waste streams of each study area were not always included. Maple Ridge and Kamloops compositions do not include wastes from ICI self–haul sources, and other irregular sources. The overall percentages of Maple Ridge and Kamloops will change by including ICI wastes on private vehicles. For example, the percentage of construction/demolition debris will increase since these are common in ICI wastes and the percentages of other waste categories will decrease accordingly.

FIGURE 1

AVERAGE WASTE COMPOSITION
IN MAPLE RIDGE, KAMLOOPS, AND CASTLEGAR / SLOCAN VALLEY



Overall, the study revealed that by far the largest components of municipal solid waste (MSW) are paper and organics. About 32% of MSW consists of newspaper, packaging, cardboard, fine paper, magazines, and telephone books, with the first three being the largest parts of the paper component. About 32% consists of organics made up of kitchen wastes, yard wastes, landscaping wastes and wood.

Glass, metals, and plastic each form about 5% to 7% of MSW. In the glass category, non-refundable bottles made up the largest component. In metals, steel cans and other ferrous items were the largest components. In the plastic category, LDPE film, HDPE film, and HDPE rigid plastic were the largest components.

Other components made up about 17% of MSW.

These compositions are based on wet (as-received) weights, and are therefore influenced by weather conditions and cross-contamination of the various waste categories. The average amount of moisture contained in these weights and how this moisture affects composition results is presented in the section titled "Moisture Contents of the Waste Categories".

When considering these composition results, one should understand that these are presented on a percentage basis. When weights are converted into percentages, each waste category becomes dependent of the other categories. This means that an increase in the percentage of one type of waste reduces the percentages of the other categories.

WASTE VARIABILITY

The composition of wastes varies depending on the community generating the waste, (geographic location and socio-economic background), the differing waste sources (residential, ICI, urban or rural), and the season and year of waste generation.

Community

Table 8 presents the estimated waste compositions for Maple Ridge, Kamloops, and Castlegar/Slocan Valley. When comparing composition results, it is important to compare percentages based on similar waste streams and based on similar generation rates. For example, newspaper makes up a larger percentage of the wastes from a town with a well–established program (Maple Ridge), than from a town with few opportunities for recycling (Kamloops). These percentages could be interpreted to mean that more newspaper is discarded in Maple Ridge. In fact, when waste percentages are converted to generation rates, we see that this is not the case. Considering only the waste streams surveyed, the amount of newspaper discarded in Maple Ridge is about 29.6 kilograms per person per year, whereas in Kamloops this amount is as much as 38 kilograms per person per year. Therefore, to compare composition results from communities with different generation rates, waste percentages should be converted to per capita generation rates.

Even though the percentages of the waste categories from different communities may be quite similar, the amounts discarded on a per capita basis may, in fact, be very different.

Waste Sources

Residential waste sources generate different wastes from ICI sources. Wastes from urban sources are different from those from rural sources. Table 9 was compiled to demonstrate waste variability from different waste sources. It summarizes the compositions of wastes on residential, ICI and combined collection vehicles servicing Maple Ridge, Kamloops, Castlegar and Slocan Valley. The compositions presented are the average values of the fall and spring survey results.

In Maple Ridge and Kamloops, residential curbside wastes are collected separately from wastes stored in bins. Wastes in bins come from ICI sources and also from multi–family dwellings (apartments). In Castlegar, all wastes are collected in one vehicle. Slocan Valley wastes included ICI wastes, although these were a very small fraction of the total.

TABLE 8. OVERALL WASTE COMPOSITION IN MAPLE RIDGE, KAMLOOPS, AND CASTLEGAR / SLOCAN VALLEY

BASED ON WET WEIGHTS

COMPONENTS	MAPLE RIDGE	KAMLOOPS	CASTLEGAR SLOCAN VALLEY
Paper (total)	**33.0%**	**28.9%**	**33.4%**
newspaper	7.4%	6.3%	5.6%
cardboard	7.8%	4.8%	8.4%
fine	2.1%	2.8%	2.7%
glossy / telephone	2.8%	2.8%	3.6%
packaging	4.3%	4.4%	4.4%
aseptic cartons	0.3%	0.4%	0.4%
non–packaging	3.7%	3.7%	4.0%
other / multi–material	1.3%	1.4%	1.2%
contaminated	3.3%	2.5%	3.1%
Glass (total)	**5.0%**	**4.8%**	**6.4%**
beverage – refundable	0.7%	0.5%	0.6%
beverage – nonrefundable	2.1%	2.0%	2.4%
food	1.7%	1.2%	1.9%
other	0.6%	1.0%	0.8%
Metals (total)	**5.3%**	**5.0%**	**6.2%**
alum. bev. – refundable	0.2%	0.2%	0.1%
alum. bev. – nonrefundable	0.0%	0.0%	0.0%
other aluminum	0.6%	0.4%	0.5%
steel beverage	0.0%	0.0%	0.0%
other steel cans	1.9%	1.7%	2.6%
other ferrous	1.6%	2.0%	2.3%
non–ferrous	0.0%	0.1%	0.0%
other / multi–material	0.9%	0.6%	0.7%
Plastic (total)	**8.2%**	**6.0%**	**7.3%**
PET beverage (1)	0.1%	0.1%	0.1%
other PET	0.1%	0.1%	0.0%
HDPE (2) rigid	1.1%	0.9%	1.0%
LDPE (4) rigid	0.2%	0.1%	0.1%
HDPE (2) film	1.3%	2.0%	2.3%
LDPE (4) film	2.7%	1.1%	1.4%
PVC (3)	0.2%	0.1%	0.1%
PS (6)	0.8%	0.7%	0.7%
PP (5)	0.6%	0.3%	0.3%
other plastics (7)	0.2%	0.1%	0.3%
multi–resin / material	0.9%	0.5%	0.7%
Leather	**0.4%**	**0.2%**	**0.4%**
Rubber (total)	**1.1%**	**1.9%**	**1.3%**
used tires	0.5%	1.7%	1.1%
other	0.7%	0.3%	0.3%
Organic (total)	**30.9%**	**37.4%**	**28.8%**
kitchen – animal	3.0%	2.8%	3.0%
kitchen – vegetable	12.7%	12.9%	15.9%
yard waste	6.7%	4.2%	2.6%
landscaping	4.9%	13.6%	3.0%
wood	3.5%	4.0%	4.1%
Textiles (total)	**2.8%**	**2.1%**	**1.9%**
natural	0.9%	0.4%	0.5%
synthetic	1.9%	1.7%	1.4%
Brown goods	**0.4%**	**1.0%**	**1.4%**
Bulky goods	**2.0%**	**0.8%**	**1.1%**
White goods	**0.0%**	**1.8%**	**0.8%**
Construction, Demolition	**4.5%**	**4.2%**	**4.9%**
Residue	**3.6%**	**4.2%**	**3.9%**
Hazardous	**2.6%**	**1.5%**	**1.7%**
Other	**0.1%**	**0.1%**	**0.3%**

TABLE 9. SUMMARY OF COMPOSITIONS OF WASTES ON COLLECTION VEHICLES

BASED ON WET WEIGHTS

COMPONENTS	RESIDENTIAL		ICI		RESIDENTIAL AND	
	Maple Ridge	Kamloops	Maple Ridge	Kamloops	Castlegar	Slocan
Paper (total)	**37.9%**	**36.4%**	**42.8%**	**40.1%**	**42.6%**	**36.9%**
newspaper	8.7%	10.2%	9.1%	6.5%	7.7%	5.1%
cardboard	4.5%	3.8%	13.3%	8.8%	10.6%	7.6%
fine	2.2%	2.4%	3.0%	4.9%	3.5%	3.2%
glossy / telephone	3.8%	4.1%	2.5%	3.2%	4.4%	4.6%
packaging	6.3%	6.3%	5.1%	5.3%	5.5%	5.4%
aseptic cartons	0.6%	0.3%	0.2%	0.7%	0.5%	0.4%
non-packaging	4.6%	3.6%	4.6%	6.2%	5.3%	4.8%
other / multi-material	1.4%	1.6%	1.8%	2.1%	1.6%	1.2%
contaminated	5.8%	4.2%	3.4%	2.4%	3.4%	4.6%
Glass (total)	**6.4%**	**5.6%**	**4.0%**	**6.8%**	**5.6%**	**8.0%**
beverage - refundable	0.9%	0.4%	0.4%	0.9%	0.7%	0.9%
beverage - nonrefundable	2.6%	2.7%	1.7%	2.7%	2.2%	4.2%
food	2.4%	2.1%	1.3%	1.1%	1.7%	2.3%
other	0.5%	0.5%	0.6%	2.1%	0.9%	0.6%
Metals (total)	**6.0%**	**5.5%**	**6.1%**	**6.6%**	**5.9%**	**6.5%**
alum. bev. - refundable	0.2%	0.1%	0.2%	0.3%	0.2%	0.1%
alum. bev. - nonrefundable	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
other aluminum	0.7%	0.6%	0.7%	0.5%	0.4%	0.4%
steel beverage	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
other steel cans	3.1%	3.0%	1.9%	1.4%	3.1%	3.5%
other ferrous	0.9%	0.9%	2.0%	3.6%	1.4%	1.2%
non-ferrous	0.0%	0.1%	0.0%	0.1%	0.0%	0.2%
other / multi-material	1.0%	0.7%	1.2%	0.6%	0.7%	1.0%
Plastic (total)	**8.8%**	**8.0%**	**10.6%**	**7.5%**	**8.8%**	**8.5%**
PET beverage (1)	0.1%	0.0%	0.1%	0.1%	0.2%	0.1%
other PET	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
HDPE (2) rigid	1.1%	1.3%	1.5%	0.9%	1.2%	1.5%
LDPE (4) rigid	0.3%	0.2%	0.3%	0.2%	0.1%	0.2%
HDPE (2) film	1.3%	2.9%	1.1%	2.5%	3.2%	2.9%
LDPE (4) film	3.5%	1.5%	4.0%	1.4%	1.5%	1.6%
PVC (3)	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%
PS (6)	0.9%	0.8%	1.0%	1.0%	1.0%	0.7%
PP (5)	0.5%	0.4%	1.0%	0.3%	0.3%	0.5%
other plastics (7)	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%
multi-resin / material	0.9%	0.6%	1.2%	0.6%	0.7%	0.7%
Leather	**0.5%**	**0.4%**	**0.4%**	**0.2%**	**0.1%**	**0.6%**
Rubber (total)	**0.3%**	**0.3%**	**1.0%**	**3.1%**	**0.3%**	**0.3%**
used tires	0.0%	0.0%	0.2%	2.8%	0.0%	0.0%
other	0.3%	0.3%	0.7%	0.3%	0.3%	0.3%
Organic (total)	**28.4%**	**32.6%**	**21.5%**	**23.5%**	**26.0%**	**27.8%**
kitchen - animal	4.0%	5.1%	2.5%	2.1%	3.4%	3.3%
kitchen - vegetable	17.4%	18.3%	12.8%	15.7%	18.2%	22.4%
yard waste	5.8%	8.2%	2.9%	1.6%	2.2%	0.8%
landscaping	0.2%	0.2%	0.2%	0.7%	0.0%	0.1%
wood	1.0%	0.8%	3.1%	3.3%	2.1%	1.2%
Textiles (total)	**2.8%**	**3.0%**	**3.4%**	**2.4%**	**1.8%**	**3.1%**
natural	0.9%	0.7%	1.5%	0.5%	0.6%	0.7%
synthetic	1.9%	2.3%	1.9%	1.9%	1.3%	2.3%
Brown goods	**0.6%**	**0.7%**	**0.4%**	**1.5%**	**0.8%**	**0.7%**
Bulky goods	**0.5%**	**0.3%**	**1.6%**	**0.7%**	**0.3%**	**0.3%**
Construction, Demolition	**1.3%**	**0.5%**	**0.4%**	**2.5%**	**1.7%**	**1.1%**
Residue	**4.1%**	**4.9%**	**4.5%**	**3.4%**	**4.1%**	**4.4%**
Hazardous	**2.3%**	**1.7%**	**3.1%**	**1.6%**	**1.8%**	**1.5%**
Other	**0.0%**	**0.2%**	**0.1%**	**0.0%**	**0.0%**	**0.4%**

Residential and ICI Sources

Residential loads and ICI loads contained similar proportions of paper, but the make–up of that paper varied. In ICI loads, the largest component was cardboard. Newspaper, non–packaging (towels, napkins, and mail), and packaging also made up large parts of ICI paper waste. In residential paper waste, newspaper was the largest component, followed by packaging. Contaminated paper (disposable diapers and sanitary pads) was a large part of the residential paper component, as were magazines, telephone books, and cardboard.

There was a significantly higher proportion of glass food jars and steel cans in residential loads. Therefore a recycling program for these glass and metal products would reduce a greater percentage of waste from residential wastes than from ICI wastes.

Organic waste formed a slightly larger proportion of residential than of ICI waste. Vegetable wastes from the kitchen made up the largest proportion of organic waste in both residential and ICI waste. In ICI waste, the second largest percentage was wood waste. In residential waste, kitchen wastes of animal origin and yard waste have the next largest percentages.

The remaining components of MSW make up similar proportions of both ICI and residential waste, although more rubber tires were found in ICI loads.

Urban and Rural Sources

The comparison between urban and rural waste streams showed that a greater percentage of the waste in urban areas is paper. A greater percentage of the waste from rural sources is glass, in particular, non–refundable beverage glass. Assuming similar participation rates in both urban and rural areas, we expect that a paper recycling program would reduce a greater percentage of the waste stream from urban areas whereas a glass recycling program would reduce a greater percentage of the rural waste stream.

Seasonal Variation

Waste composition varies with the seasons of the year. One goal of performing the survey twice at each site was to capture some seasonal variation in the waste stream. Therefore, survey results from the fall were compared with those from the spring. For example, Table 10 presents the average compositions of Kamloops' residential wastes on collection vehicles for both the fall and spring surveys.

Statistical comparison of compositions show that the percentages of corrugated cardboard, total organics due to yard wastes, and natural textiles are higher in the fall survey than in the spring survey. Percentages of fine paper, glass food containers, other glass, total metals due to the steel cans and multi–material metals, and multi–resin/multi–material plastics are significantly higher in the spring survey.

The fall and spring waste streams of Maple Ridge, Castlegar and Slocan Valley were all compared (GLL, 1991). Each comparison showed that the waste compositions varied between the fall and spring surveys. The variations between the fall and spring survey results in each community were between different waste categories. These comparisons emphasis the changing nature of waste composition.

MOISTURE CONTENTS OF WASTE CATEGORIES

It is valuable to know the moisture contents of the components of a composition analysis. Moisture contents are used to convert wet (as–received) weights into dry weights. Dry weight percent composition, based on the weight of material when it has all of its moisture removed, is used to compare the percent compositions in samples taken under different conditions. If wet weights are not converted to dry weights, uncertainty about the amount of moisture in the weights handicaps the analysis.

TABLE 10. COMPARISON OF FALL AND SPRING COMPOSITIONS (KAMLOOPS RESIDENTIAL WASTE)

BASED ON WET WEIGHTS

COMPONENTS	PERCENT COMPOSITION	
	FALL SURVEY	SPRING SURVEY
Paper (total)	**33.2%**	**39.6%**
newspaper	9.5%	10.8%
cardboard	4.4%	3.2%
fine	1.8%	3.0%
glossy / telephone	3.0%	5.1%
packaging	5.8%	6.8%
aseptic cartons	0.3%	0.3%
non–packaging	3.8%	3.5%
other / multi–material	1.1%	2.0%
contaminated	3.5%	4.9%
Glass (total)	**5.1%**	**6.1%**
beverage – refundable	0.5%	0.3%
beverage – nonrefundable	2.6%	2.7%
food	1.7%	2.5%
other	0.2%	0.7%
Metals (total)	**4.8%**	**6.2%**
alum. bev. – refundable	0.2%	0.1%
alum. bev. – nonrefundable	0.0%	0.0%
other aluminum	0.5%	0.7%
steel beverage	0.1%	0.0%
other steel cans	2.5%	3.5%
other ferrous	0.9%	0.8%
non–ferrous	0.1%	0.0%
other / multi–material	0.5%	0.9%
Plastic (total)	**7.4%**	**8.5%**
PET beverage (1)	0.0%	0.1%
other PET	0.1%	0.1%
HDPE (2) rigid	1.0%	1.5%
LDPE (4) rigid	0.1%	0.2%
HDPE (2) film	4.3%	1.4%
LDPE (4) film		3.0%
PVC (3)	0.1%	0.1%
PS (6)	0.8%	0.8%
PP (5)	0.4%	0.4%
other plastics (7)	0.1%	0.3%
multi–resin / material	0.4%	0.8%
Leather	**0.4%**	**0.4%**
Rubber (total)	**0.3%**	**0.4%**
used tires	0.0%	0.0%
other	0.3%	0.3%
Organic (total)	**37.4%**	**27.8%**
kitchen – animal	4.9%	5.4%
kitchen – vegetable	17.9%	18.7%
yard waste	13.5%	2.8%
landscaping	0.3%	0.2%
wood	0.8%	0.7%
Textiles (total)	**3.1%**	**2.8%**
natural	0.9%	0.4%
synthetic	2.1%	2.5%
Brown goods	**0.7%**	**0.7%**
Bulky goods	**0.3%**	**0.4%**
Construction, Demolition	**0.4%**	**0.7%**
Residue	**4.9%**	**4.8%**
Household Hazardous	**1.7%**	**1.7%**
Other	**0.3%**	**0.0%**

Knowledge of moisture contents of the various waste categories is also useful when estimating the weights of recyclable materials present in the waste. Clearly paper products are less contaminated when entering a recycling program than when entering a disposal site. When separated for recycling, paper products are not cross–contaminated by other wastes, and glass jars and metal cans are usually cleaned. A better estimate of the amount of recyclables present in the waste stream can be made by adjusting the weights of recyclables based on as–received moistures to more realistic moistures. In their natural states, paper has a moisture content of about 4 to 7%, plastic has a moisture of about 2%, and metals and glass have no moisture.

Moisture contents are also useful for proper control of composting or digestion of the waste. They can also be used to determine the energy needed to burn the waste if incineration is considered as a disposal option, or to estimate the amount of leachate that a landfill will produce.

The amount of moisture contained in the waste changes the values of percent composition. For example, Table 11 compares percent composition figures from wastes on residential collection vehicles in Kamloops using "wet" and "dry" weight data.

TABLE 11 COMPARISON OF PERCENT COMPOSITIONS USING WET AND DRY WEIGHTS (KAMLOOPS RESIDENTIAL WASTE)

Category	Average % Composition Using Wet Weights	Average % Composition Using Dry Weights
Paper	36.4	39.7
Glass	5.6	8.2
Metals	5.5	7.3
Plastic	8.0	9.0
Leather	0.4	0.6
Rubber	0.3	0.5
Organic	32.5	21.8
Textiles	3.0	3.7
Brown Goods	0.7	0.9
Bulky Goods	0.3	0.4
Construction	0.5	0.7
Household Hazardous	1.7	2.6
Residue	4.9	4.4
Other	0.2	0.2

This comparison shows the importance of making clear the moistures contained in the weights upon which percent composition is reported. The table shows that by drying all categories to a consistent dry standard, percent composition by weight for some waste categories changes substantially. For example, the percent composition by weight of organics drops by over 10% and the relative percentage of many categories, notably paper, glass and metals, increases to make up the difference.

The components of the waste are contaminated by each other during the disposal and collection process. Moisture contents can be altered considerably depending on the type of collection, the time between collections and weather conditions en route. Wastes from different seasons or geographic locations can have considerably different moisture contents.

Figure 2 presents the estimated total moisture content of each load of MSW analyzed. These estimates are made using actual or estimated moisture values of each component and the percentage of each component in the load. Moisture content values from Slocan Valley were plotted with those from Castlegar since they were taken during the same week. The vertical axis of Figure 2 has no numerical importance; it is included to segregate the moisture values from each area during the fall and spring survey periods.

Table 12 shows the average moisture contents of various waste components. Items most susceptible to variation in moisture content from contamination are paper products, plastics, some metals, and textiles. The moisture contents of contaminated papers (i.e., diaper and sanitary pads) vary considerably due to the nature of their contamination. Aseptic cartons, aluminum beverage containers, other aluminum, rigid and film plastics and polystyrene all have highly variable moisture values since the weight of contamination can be significant compared to their own weights. Multi–material metals and plastics have high and variable moisture values depending on the amount of paper involved. The moisture contents of glass, leather, rubber, wood, some metals, white goods, bulky goods, brown goods and household hazardous wastes are relatively consistent.

The total moisture content of MSW generated in B.C. is estimated to be 30.3%.

Figure 2

Moisture Content Values for Mixed Refuse

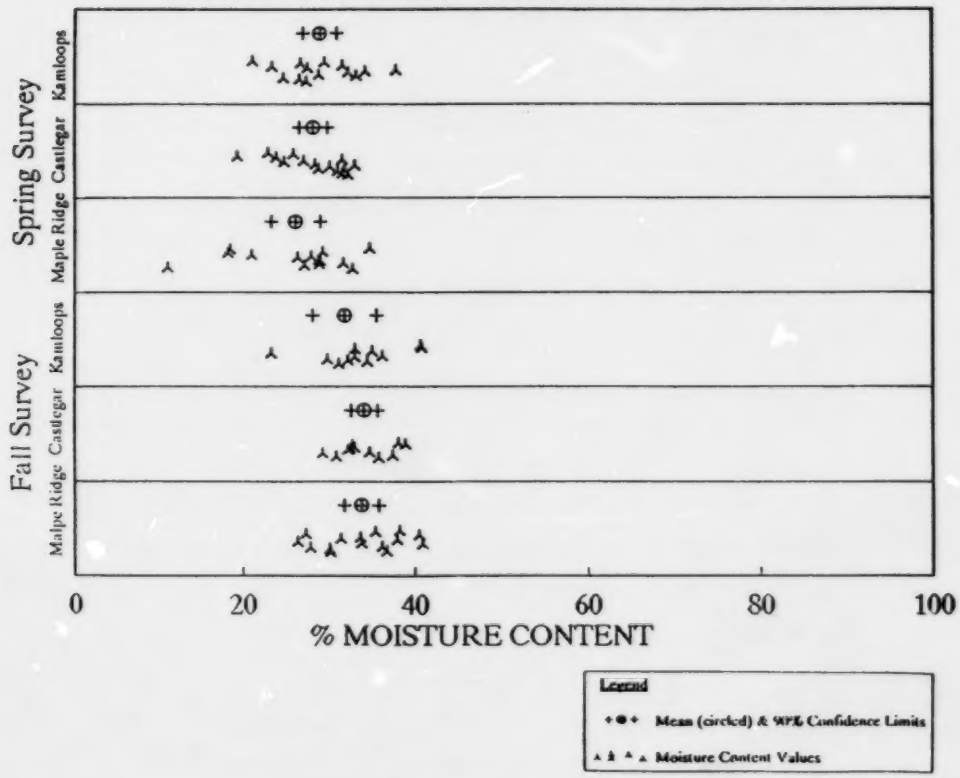


TABLE 12. MOISTURE CONTENTS OF WASTE CATEGORIES

Category	Moisture Content (%)
Paper	
newspaper	30.6
cardboard	32.5
fine	21.8
glossy / telephone	16.6
packaging	27.5
aseptic cartons	18.2
non–packaging	39.1
other / multi–material	25.0
contaminated	27.0
Glass	
beverage	1.8
food / container	4.0
Metals	
aluminum beverage	11.1
aluminum other	22.0
steel cans	8.4
other / multi–material	17.4
Plastic	
hard	11.9
film	25.4
PS	18.8
multi–resin / multi–material	16.1
Organic	
kitchen animal	38.3
kitchen vegetable	59.8
yard waste	56.1
Textiles	20.2
Residue	35.1
Total	30.3

VOLUME CALCULATION

The densities of the five main waste categories: paper products, glass, metals, plastics and organics, were estimated in order to convert weights to volumes. Since waste density depend on the degree of compression, we tried to estimate the density at which it was received at the disposal site. The results of the density estimates are presented in Table 13.

TABLE 13 DENSITIES OF WASTE COMPONENTS AS RECEIVED AT THE DISPOSAL SITE

	Number of Samples	Average Density (kg/m^3)	Standard Deviation (kg/m^3)
Paper products	22	122	27
Glass	22	308	52
Metals	25	115	49
Plastics	26	54	15
Organics			
– Kitchen wastes	25	484	42
OVERALL	18	133	18

Paper products, glass, metals and plastics all include all sub–categories in the density calculation. Organics include only kitchen wastes of animal and vegetable origin. Densities for yard wastes, landscaping wastes, wood, textiles, leather, rubber, brown goods, bulky goods, construction/demolition wastes, hazardous wastes and residue were not obtained.

A comparison of the waste densities of Table 13 shows that, as received at the disposal site, plastics take up five times the volume per unit of weight that organic kitchen wastes do, and twice as much as paper products and glass.

The combined density of these five components is presented in Table 13 as the overall density. The loads in this survey came mostly from compactor trucks, but in some cases were loose refuse from non–compactor or private vehicles. Typical densities of mixed municipal refuse are 59 – 118 kg/m^3 for loose refuse with no processing, and 207 – 236 kg/m^3 for refuse from a compactor truck, after dumping. The estimated density of mixed refuse from this survey is lower than the expected typical values for compactor trucks. Compactor trucks have differing degrees of compaction depending on the type of truck and the amount of refuse being compacted. The highest density obtained in this survey was 165 kg/m^3 and the lowest was 101 kg/m^3.

REFERENCES

Bird and Hale Ltd., "Municipal Refuse Statistics for Canadian Communities of Over 100,000 (1976–1977)", EPS no. 4672–1, Oct. 1979.

Gartner Lee Limited, "Procedural Manual for Municipal Solid Waste Composition Analysis" for B.C. Ministry of Environment, April, 1991.

Gartner Lee Limited, "Determination of MSW Composition of Four Communities in B.C.: Procedures–Testing and Results" for B.C. Ministry of Environment, September, 1991.